1549 347 COMPLETE SPECIFICATION

3 SHEETS This drawing is a reproduction of the Original on a reduced scale.

SHEET 1

Fig.1.

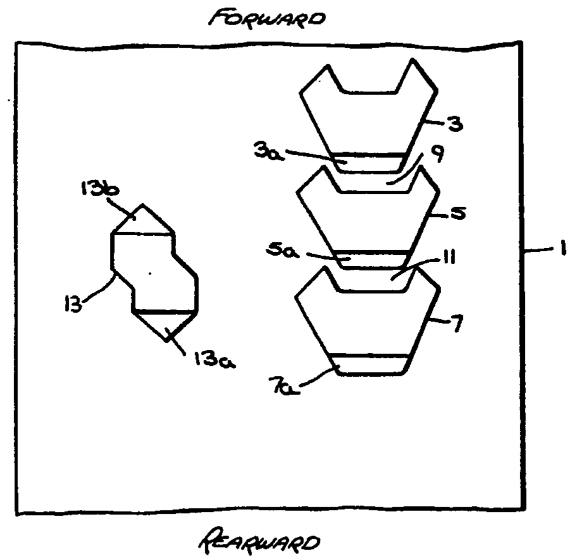


Fig.6.

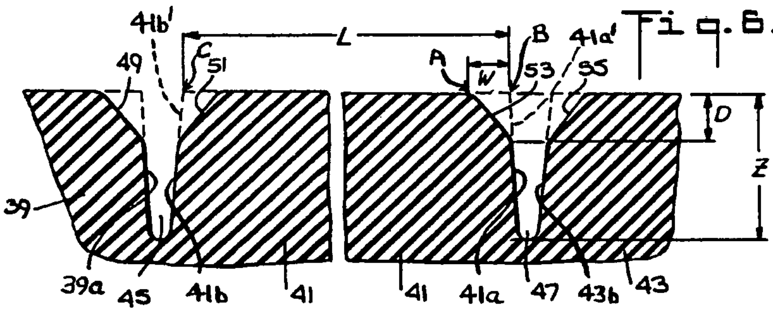
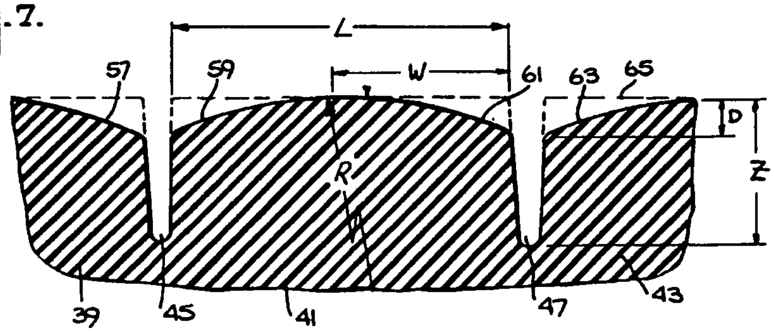


Fig.7.



1 549 347 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*

SHEET 2

Fig. 2.

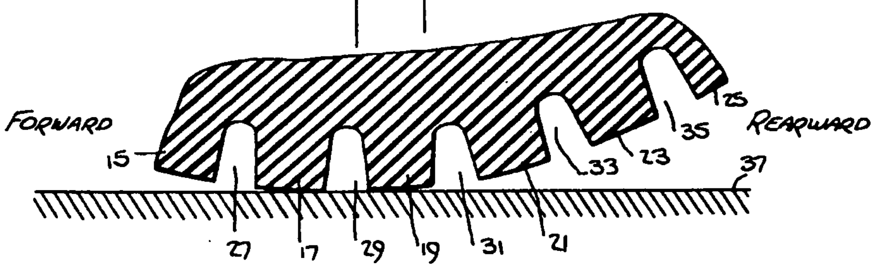


Fig. 3.

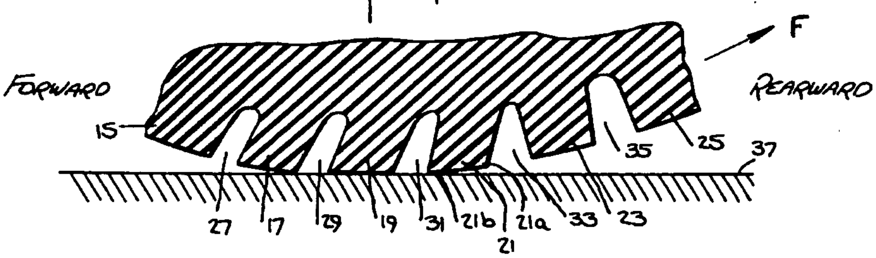


Fig. 4.

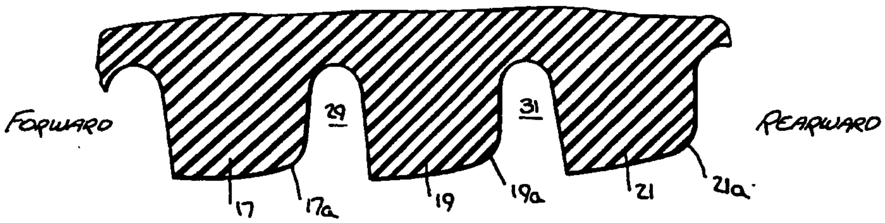
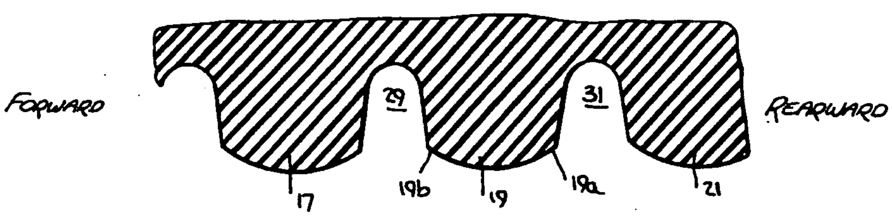


Fig. 5.



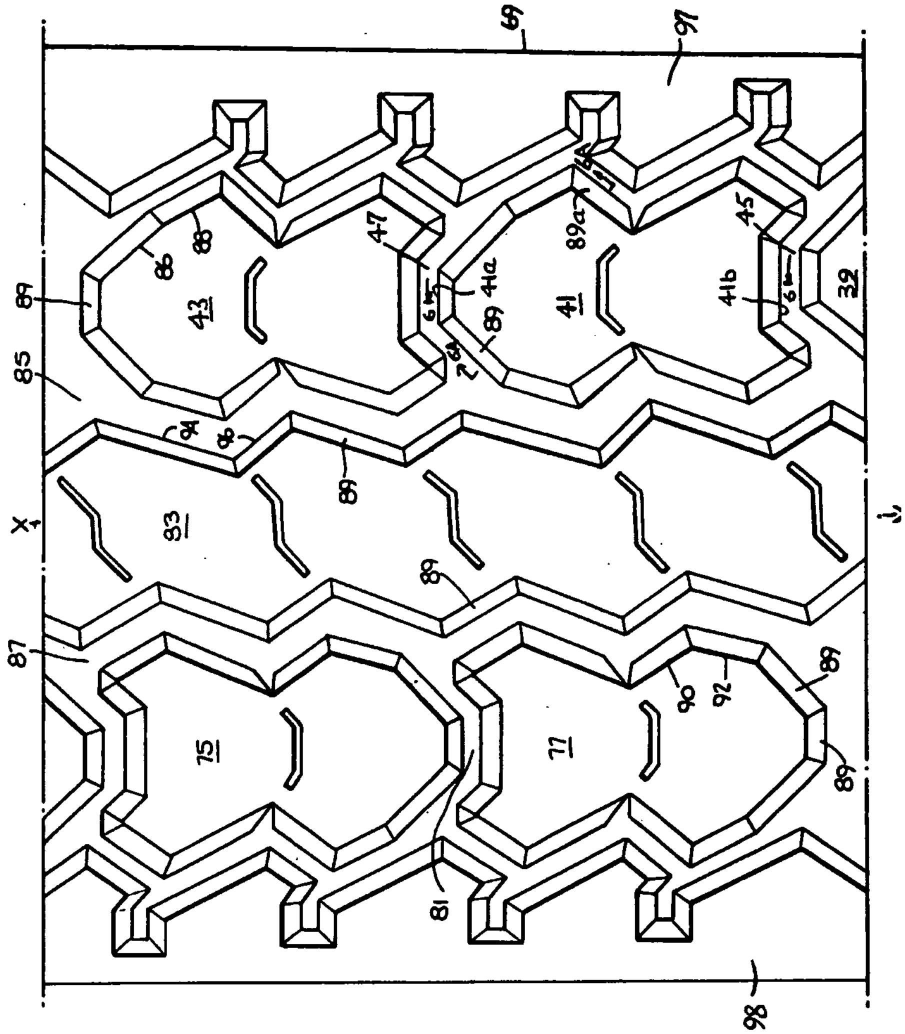


Fig. 8.

PATENT SPECIFICATION

(11) 1 549 347

(21) Application No. 19692/76 (22) Filed 13 May 1976
(31) Convention Application No. 7 517 003 (32) Filed 30 May 1975 in
(33) France (FR)
(44) Complete Specification published 1 Aug. 1979
(51) INT. CL.^{2} B60C 11/04
(52) Index at acceptance
B7C 3D3

1 549 347

(19)

(54) PNEUMATIC TIRES

(71) We, UNIROYAL, a corporation organized under the laws of France, located at Clairoix (60), France, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a pneumatic vehicle tire and more particularly but not exclusively to a tread structure of such a tire, the tread structure having chamfered lugs and ribs.

Pneumatic vehicle tires presently in use have tread constructions which include a plurality of circumferentially extending rows of lugs and ribs, which rows and ribs are separated from one another by circumferentially extending grooves, the lugs being further separated from one another by transversely extending grooves. Such tires, in which the grooves extend radially from within the tread body to the radially outward surface thereof have been found to be generally satisfactory for in-service use on a vehicle, that is, they have been found to be generally satisfactory for their intended functions such as vehicle support and traction. The treads are, however, as is well known, subject to substantial wear, which wear ultimately requires either the retreading or replacement of the tire, both of which entail substantial expense. In this regard it has been noted that the aforementioned conventionally treaded tires, that is, tires having treads in which the grooves separating the ribs and lugs extend radially to the radially outward surface of the tread exhibit a deleterious wear phenomenon peculiar to the outer edges of the ribs and lugs. More particularly, this wear primarily occurs at the rearward edges, with respect to the rolling direction of the tire, of the lugs.

Wear of the kind here being discussed, which is superimposed over the general wear that is taking place in the tread, is caused by the rubbery material lugs of the tread, which are in contact with the road surface, being circumferentially deformed during operation. This deformation takes the form of the lugs being flexed obliquely toward the rear relative to the direction of motion of the vehicle on which the tires are mounted because of the twisting torque between the tire rim and the road surface, and the deformed lugs resume their initial state only when the lugs are displaced rearwardly and upwardly as the tire rolls. The lugs therefore are subjected to a movement, i.e., a deformation, in addition to the conventional rolling movement. The additional movement or deformation which affects each lug occurs, clearly, only during a fraction of each revolution of the wheel and it corresponds to a slippage of the rear portion (relative to the direction of rotation of the tire) of the lug which is pressed against the road surface by a pressure force that is weaker than the pressure force acting against the front or forward portion of the lug and the localized wear at the rear portion of the lug results from the slippage due to the lower pressure force.

At this point it is appropriate to note that the edges of the sides of the lugs, and the edges of the sides of the ribs as well, of the tread are also subjected to wear which, although of the same type, is substantially less severe. This edge wear of the lugs and ribs is caused by the lateral deformation of the lugs and ribs during turns and by the lateral deformations to which the lugs and ribs are subjected during straight line travel because of tire squirm and because of the flexibility i.e., elasticity, of the tread rubber.

Clearly, a tire tread structure which is as satisfactory as conventionally treaded tires for its intended functions and which addi-

tionally exhibits improved wearing characteristics relative to known tread structures by eliminating, or at least reducing, lug edge wear would be most desirable.

According to the present invention a pneumatic tire for a vehicle has a tread comprising a plurality of lugs, each lug having a radially outer surface and sides extending from the bases of grooves around the lug towards the radially outer surface, wherein the whole length of one side of each lug is chamfered adjacent to the radially outer surface and, for each lug, the dimensions of any part of the respective chamfer fall within limits determined from the figure formed by projecting the sides of that lug to meet the envelope of the tread in a series of reference lines, the limits being determined as follows:—

i) any line is drawn that is perpendicular to the reference line of the chamfered side and that intersects at point (A) the junction of the chamfer with the tread envelope, at point (B) the reference line of the chamfered side, and at point (C) the reference line of another side of the lug;

ii) the length of such line between points (B) and (C) is denoted L and the width W of the part of the chamfer measured along such line between points (A) and (B) is between the limits 0.15L and 0.5L; and

iii) the depth D of the part of the chamfer along such line is between the limits 0.2Z and 0.4Z, where Z is the depth of the groove adjacent to said chamfered side, both depths D and Z being measured along a radius of the tire from point (B).

More than one side of at least one lug of the tire may be chamfered, the chamfer of any or all of such further sides falling within limits determined as set forth above.

Usually the tread further comprises a circumferentially continuous rib, the sides of which are in a zig-zag configuration, said rib being separated from said plurality of lugs by grooves. In such cases at least one side of said rib may be chamfered, and the dimensions of any part of such chamfer preferably fall within limits determined as set forth above.

The invention will be more clearly understood from the following detailed description thereof when read in conjunction with the accompanying drawings, in which:—

Figure 1 is a schematic plan view of a portion of the surface of a tread illustrating the wear pattern of conventional lugs;

Figure 2 is a schematic sectional view of a portion of a conventional tire tread in contact with a road surface, which view is taken along the equatorial plane of the tire;

Figure 3 is similar to Figure 2 excepting that the deformation of the tread lugs when the tire is rolling is here illustrated;

Figure 4 is a schematic sectional view of a portion of a conventional tread, taken along the equatorial plane of a tire, after use;

Figure 5 is similar to Figure 4 excepting that tread lug wear after the tire has been in-service in both the forward and rearward directions is here illustrated;

Figure 6 is a broken cross-sectional view of a portion of a tire tread taken along either of the lines 6-6 in Figure 8 illustrating a lug structure in accordance with a first embodiment of the invention;

Figure 7 is similar to Figure 6 and illustrates a lug structure in accordance with a second embodiment of the invention; and

Figure 8 is a plan view of a portion of a tread, the lugs and ribs of which are structured in accordance with the invention.

Turning now to Figure 1 there is illustrated a schematic plan view of a portion of a conventional tire tread 1 which includes a plurality of lugs 3, 5 and 7 which are independent of, and separated from, one another by grooves 9 and 11 and a lug 13 having a different shape than that of the lugs 3, 5 and 7. The tread will also conventionally include a plurality of continuous circumferential ribs not here illustrated.

The direction of rolling of the tread is indicated by the words FORWARD and REARWARD and the wear pattern of the lugs (relative to the type of wear here under discussion) which is caused by rolling in the forward direction is indicated at the rear of the lugs at 3*a*, 5*a*, 7*a* and 13*a*. With respect to the lug 13 there is also illustrated, at 13*b*, the wear pattern which will result from a reversal of the rolling direction. Such a reversal might occur, for example, when, for purposes of periodic maintenance, the tires are shifted to the opposite side of the vehicle on which they are mounted.

Turning now to Figs. 2-5, each of which is a schematic cross-sectional view of a portion of a tread taken through the equatorial plane of a tire, the cause and the mode of occurrence of the aforementioned wear will now be described. Referring first to Figure 2, there are illustrated lugs 15, 17, 19, 21, 23 and 25, each of which is similar to the lugs 3, 5, and 7 or 13 illustrated in Figure 1. Again, as in Figure 1, the lugs are separated by grooves, here indicated at 27, 29, 31, 33 and 35. Figure 2 illustrates the tire tread in contact with a road surface 37, the tire being in contact with the road surface but not under-

going rotation. Under these conditions it will be noted that the grooves, indicated at 27, 29, 31 and 33 are not deformed and the region or portion of the tread which is in contact with the road surface 37 has virtually the same configuration as those portions of the tire tread which are not in contact with the road surface, with the exception, of course, that those portions which are in contact with the road surface 37 are slightly flattened due to loading.

Referring now to Figure 3 which shows the same tread portion as illustrated in Figure 2, with the exception that the tread section of Figure 3 is shown in the configuration achived during rotation of the tire, it can be seen that the lugs 17, 19 and 21 have been deformed so that the grooves 29 and 31 no longer extend radially of the tire, but rather, are oblique with respect thereto. Thus, the open portion of the groove, i.e., that portion adjacent the road surface, is shifted in the forward direction while the bottom of the groove, i.e. the radially inward portion thereof, is shifted rearwardly. It will also be noted that the groove 35 which has been, but no longer is, in contact with the road surface 37 has resumed its "normal", that is, radially extending, state. Thus, groove 35 extends radially of the tire; the grooves 27 and 33 are in an intermediate state of deformation; the groove 27 is going toward the state of maximum deformation; and the groove 33 is going toward the normal condition.

The deformation of the lugs is caused by the force indicated at F in Fig. 3, which force is a result of the torque between the tire rim and the tread surface, the torque being a function of the elasticity of the rubbery material of the tread and the adhesion between the tread and the road surface 37. In going from the configuration of lug 19 which is in its deformed state to the configuration of lug 25 which is in its normal state, each lug undergoes, in addition to the general rolling movement, a slippage movement which affects the front and rear portions of the lug differently. Thus, the localized wear which has been said to occur at the rearward portion of each lug is caused by the fact that the rear portion of each lug, indicated at 21*a* with respect to lug 21, is subjected to less compression then the front edge thereof, indicated at 21*b* with respect to lug 21, during the aforenoted slippage movement.

Turning now to Figure 4 there is illustrated a view of the tread portion illustrated in Figs. 2 and 3 after its in-service use in the forward direction only. It will be noted that the lugs 17, 19 and 21 exhibit a saw-tooth profile showing asymmetric wear of the lugs. Thus, the rear edges of lugs 17, 19 and 21, indicated at 17*a*, 19*a*, and 21*a*, respectively, are worn whereas the front edges of the lugs are not worn.

Figure 5 illustrates the tread portion shown in Figure 4 after the tread has been in use in both the forward and rearward directions. Figure 5 shows that if the tread is used in-service in both directions under similar conditions and for equal distances, the tread will show a generally symmetrical wear profile with the edges 19*a* and 19*b* of the lug 19 showng virtually identical wear.

It has been found that the type of lug edge wear illustrated in Figures 4 and 5 will, if initiated, continue indefinitely without stabilizing. That is, once this type of wear has begun it will continue and will not reach a point of wear at which the lug rear edge wear will cease. It has further been found, however, that, where the sides of the lugs and ribs have been chamfered as further described herein, this type of edge wear is not initiated and tread life is therefore substantially extended. Further, the effectiveness of the tread is improved due to the fact that tread wear is transferred to the central portion of the lugs and ribs thereby providing a more uniform wearing of the tread. It has further been found that the optimum profile of the chamfers when seen in cross-section perpendicular to the chamfered side corresponds to a curve which is a function of numerous parameters, one of which parameters relates to the mode of operation of the vehicle on which the tire is mounted. It may therefore be seen that it is not possible to establish an optimum profile for all tires which are used for all purposes, but rather, that a structure having a profile within a range of limits is provided. In this regard it is appropriate to note that the profiles actually adopted will suitably be those requiring less complex constructions and, in particular, will be those which take into account tire molding requirements and difficulties.

Turning now to Figure 6 there is shown a broken cross-sectional view taken on line 6-6 of Figure 8, of a portion of the tire tread. This cross-section is taken along a plane parallel to the equatorial plane of the tire and it will be seen that the whole length of each of the sides 39*a*, 41*a* 41*b* and 43*b* is chamfered adjacent to the radially outer surface thereof, the chamfers being shown at 49, 53, 51 and 55. If the sides 41*a*, 41*b* of the lug 41 are projected to meet the envelope of the tread, as indicated by the broken lines 41*a*', 41*b*' in Figure 6, they will each meet the tread in a reference line. The section line 6-6 is

taken perpendicular to the reference line of side 41a and intersects that reference line at a point B, the section line also intersects the reference line of side 41b at a point C. Furthermore, the section line intersects the junction of the chamfer of side 41a with the tread envelope at the point A. The length of the section line between points B and C is indicated at L, and the width of the chamfer measured along that line between points A and B is indicated at W. The depth of the part of the chamfer along the section line is indicated at D and the depth of the groove 45 adjacent to the chamfered side 41a is indicated at Z. Both D and Z are measured along a radius of the tire from point B.

In this embodiment the chamfers 49, 51, 53 and 55, when seen in cross-section perpendicular to the chamfered edge, are rectilinear and are oblique with respect to the plane of the grooves 45 and 47 as well as with respect to the surface of the tread. It has been found that the desired reduction in wear of the edge of side 41a of the lug 41 is attained, where the dimension of the chamfer 53 along the section line 6-6 is such that the width W is between 0.15L and 0.5L and the depth D is between 0.2Z and 0.4Z, and more specifically where the width W is between 0.18L and 0.26L and the depth D is between 0.26Z and 0.34Z.

It will be understod that the section line 6-6 is only one of the lines that can be drawn perpendicular to the reference line of the chamfered side 41a. Any other line drawn perpendicular to that reference line will intersect at point A′ the junction of chamfer 53 with the tread envelope, at point B′ the reference line of the chamfered side 41a and at point C′ the reference line of another side of the lug. Thus, length L′ will be defined between points B′ and C′, length W′ will be defined between points A′ and B′, the chamfer will have a depth D′ along such line and will be adjacent to a groove of depth Z′. To give the desired reduction in edge wear for side 41a every W′ must be from 0.15 to 0.5 of the corresponding L′ and every D′ must be from 0.2 to 0.4 of the corresponding Z′.

As shown in Figure 6 the side 41b is also chamfered, and the dimensions for that chamfer are derived in the same manner as described above for the side 41a, with lines being drawn perpendicular to the reference line of the chamfered side 41b, i.e. the line where the projection of side 41b meets the envelope of the tread.

In accordance with a second embodiment of the invention there is illustrated in Figure 7 a similar portion of tread to that illustrated in Figure 6 with the exception that the chamfers of the lugs 39, 41 and 43, chamfers 57, 59, 61 and 63 respectively, are curvilinear in cross-section rather than being rectilinear in cross-section as in the embodiment illustrated in Figure 6. The profile of the chamfers in Figure 7 is that of the arc of a circle having a radius of curvature indicated at R. In this embodiment R is equal to L which, as in Figure 6, represents the length B-C derived as described above. As illustrated in Figure 7, with the radius of curvature R of the chamfer being equal to L, the width W of the chamfers 57, 59, 61 and 63 are equal to L/2. It will, of course, be realized that the embodiment illustrated in Figure 7 is subject to modification in that each of the chamfers could extend a distance somewhat less than L/2 which would result in a substantially flat zone situated in the plane 65 defining the surface of the tread. Thus, for example, with respect to lug 41, the radius of curvature R of each of the chamfers 59 and 61 could be less than L and lug 41 would therefore include a flat portion, located in the plane 65, between chamfers 59 and 61.

As previously indicated, the optimum profile of the chamfers is a curve which is a function of numerous parameters and which is related, among other things, to the mode of operation of the vehicle on which the tire is mounted. Further, for reasons of practicability, the chamfer profile selected must take into account tire molding considerations and limitations. Therefore, rather than specifically delineating the parameters defining the chamfers in the embodiment illustrated in Figure 7, a range of parameters is provided. Thus, in the embodiment illustrated in Figure 7, it has been found desirable that the radius of curvature R of a chamfer on any cross-sectional plane perpendicular to the chamfered side, be between 0.8L and 1.2L and more specifically that the radius of curvature R be between 0.95L and 1.05L. In any event, and regardless of the radius of curvature R selected, in any such cross-sectional plane the width W of the chamfer in the direction L must nevertheless be between 0.15L and 0.5L and the depth D of chamfer must be beween 0.2Z and 0.4Z.

Turning now to Figure 8, there is shown a plan view of a portion of a tread 69. The dashed line X-Y indicates the equatorial plane of the tire of which the tread 69 forms a part. The tread 69 includes a plurality of lugs indicated at 39, 41, 43, 75 and 77 which, as indicated, are independent of, and separated from, one another. For example, the lugs 39 and 41 are separated by a groove 45 and the lugs 75 and 77 are separated by a groove 81. The tread 69 further includes a plurality of circumferentially continuous ribs, a central rib 83 and two outer ribs 97, 98. The rib 83 is

separated from the lugs by grooves 85 and 87. As illustrated, the adjacent sides of each of the lugs, indicated at 86, 88, 90 and 92, are oblique relative to one another and the sides of the ribs 83, indicated at 94 and 96 are in a zig-zag configuration. In the description provided above with respect to Figures 2-5, the wear of the rearward portion of each of the lugs was discussed and, in Figures 6 and 7, the chamfering of this portion of each of the lugs was emphasized. However, as previously indicated, the lateral edges of the lugs and the edges of the ribs also undergo wear of the type here under discussion and both the forward and rearward edges of the lugs undergo wear due to reversal of the direction of rotation of the tire. Therefore, it has been found advantageous to chamfer all the sides of the lugs and of the ribs. In accordance with this objective all the sides of the lugs and of the ribs illustrated in Figure 8 are chamfered, each of these chamfers being indicated at 89. It will be realised, of course, that on each lug at least one, and preferably all of the chamfers 89 satisfies the relationships previously set forth, although for the sake of convenience not all the chamfers shown in the drawings necessarily satisfy that relationship.

Thus, each chamfered side, for example side 89*a* may be projected to meet the envelope of the tread in a reference line. Any cross-section may then be taken perpendicular to that reference line, for example cross-section 6A and that cross-section will have a configuraton similar to that of the central lug shown in Figure 6 or 7. Points A″, B″ and C″ will be defined on the cross-section similar to points A, B and C and dimensions W″, L″, D″ and Z″ may be measured similarly to dimensions W, L, D and Z. Each width W″ should then desirably be between 0.15 and 0.5 of the corresponding L″ and each depth D″ should desirably be between 0.2 and 0.4 of the corresponding Z″. Clearly, of course, the structure of the chamfers may meet the more limited relationships discussed above with respect to depth and width and may, in addition, be either curvilinear or rectilinear in cross-section.

It has been found that the tread structure described serves to prevent or to reduce the commencement of localized tread edge wear and therefore has resulted in a substantial extension of tread life.

WHAT WE CLAIM IS:—

1. A pneumatic tire for a vehicle, having a tread comprising a plurality of lugs, each lug having a radially outer surface and sides extending from the bases of grooves around the lug towards the radially outer surface, wherein the whole length of one side of each lug is chamfered adjacent to the radially outer surface and, for each lug, the dimensions of any part of the respective chamfer fall within limits determined from the figure formed by projecting the sides of that lug to meet the envelope of the tread in a series of reference lines, the limits being determined as follows:—

i) any line is drawn that is perpendicular to the reference line of the chamfered side and that intersects at point (A) the junction of the chamfer with the tread envelope, at point (B) the reference line of the chamfered side, and at point (C) the reference line of another side of the lug;

ii) the length of such line between points (B) and (C) is denoted L and the width W of the part of the chamfer measured along such line between points (A) and (B) is between the limits 0.15L and 0.5L; and

iii) the depth D of the part of the chamfer along such line is between the limits 0.2Z and 0.4Z, where Z is the depth of the groove adjacent to said chamfered side, both depths D and Z being measured along a radius of the tire from point (B).

2. A tire according to claim 1 wherein each width W is between 0.18L and 0.26L.

3. A tire according to claim 1 or claim 2 wherein each depth D is between 0.26Z and 0.34Z.

4. A tire according to any one of the preceding claims wherein at least one of said chamfers is rectilinear when seen in any cross-section perpendicular to the chamfered side.

5. A tire according to any one of claims 1 to 3 wherein at least one of said chamfers is curvilinear when seen in any cross-section perpendicular to the chamfered side, and the radius of curvature on any such cross-section is between 0.8L and 1.2L.

6. A tire according to claim 5 wherein each said radius of curvature is between 0.95L and 1.05L.

7. A tire according to claim 5 wherein each said radius of curvature is substantially equal to L.

8. A tire according to claim 1, in which more than one side of each lug is chamfered, the chamfer of any or all of such further sides falling within limits determined as stated in any one of the preceding claims.

9. A tire according to any one of the preceding claims wherein said tread further comprises a circumferentially continuous rib, the sides of which are in a zig-zag configuration, said rib being separated from said plurality of lugs by grooves.

10. A tire according to claim 9 wherein at least one side of said rib is chamfered and the dimensions of any part of such

chamfer fall within limits determined as stated in claim 1.

11. A tire according to claim 10 wherein said rib chamfer is rectilinear when seen in any cross-section perpendicular to the chamfered side.

12. A tire according to claim 10 wherein said rib chamfer is curvilinear when seen in any cross-section perpendicular to the chamfered side and the radius of curvature on any such cross-section is between 0.8L and 1.2L.

13. A tire according to claim 12 wherein each said radius of curvature is between 0.95L and 1.05L.

14. A pneumatic tire for a vehicle, having a tread substantially as herein described with reference to Figures 6 and 8 or to Figure 7 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1979
Published at the Patent Office, 25 Southhampton Buildings, London, WC2A 1AY, from which copies may be obtained.